
A Baseline Inventory (1995-97) and Analysis of Natural Communities, Rare Plants and Animals, Aquatic Invertebrates, and other Selected Features in Preparation for State Forest Master Planning

Biotic Inventory and Analysis of the Brule River State Forest

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Cover photograph: Calypso orchid (*Calypso bulbosa* – WI Threatened)

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Introduction

Project Purpose and Objectives

This report presents the results of a three-year project (1995-97) to inventory and analyze selected biotic resources of the Bois Brule River State Forest (BRSF) and the surrounding landscape. This project was undertaken by the Natural Heritage Inventory (NHI) section of the Wisconsin Department of Natural Resources' (WDNR) Bureau of Endangered Resources in cooperation with the Bureau of Forestry to provide baseline ecological information relevant to the development of a new property Master Plan for the Forest. This inventory and analysis is one of a number of assessments undertaken to prepare for state forest master planning. The information provided in these reports will consolidate background information useful for property master planning and other applications.

The primary objectives of this project were:

- The identification and evaluation of natural communities.
- The identification and evaluation of rare plant and animal populations.
- The identification and evaluation of selected aquatic features.
- The identification of sites appropriate for the restoration of lost or declining communities or habitats.
- To highlight especially important protection, management, and restoration opportunities, including both unique and representative natural features of the Brule landscape.
- The interpretation and transfer of the information gathered to the property master planning team, and ultimately to managers, administrators, and others involved in the implementation of land use decisions on the state forest.

Future inventory and monitoring of the biotic resources of the BRSF will be ongoing and periodic, based on needs identified in the master plan. Monitoring priorities will be established in the master plan, with adjustments made to accommodate new information using the principles of adaptive management.

Background on Past Efforts

The Bois Brule River (Brule River) was the subject of a substantial research effort coordinated by the Wisconsin Academy of Sciences, Arts, and Letters in the early 1940s. This study covered hydrology, geology, vegetation, and fisheries and provided valuable baseline information for the state forest and river. Since then, scientific examinations of the area have focused on the fishery resource (e.g., Dubois and Pratt, 1994), although plant ecology (Blewett, 1976), bryophytes (Bowers, 1996), and aquatic invertebrates (DuBois, 1993) have received some attention.

Although the Wisconsin Natural Heritage Inventory had compiled records on the occurrences of plants, animals, and natural communities of the study area from these and many other sources, no comprehensive survey of rare plants and animals had been conducted on the property prior to the current study. Our ability to establish a regional context and significance for the natural features of the BRSF has been greatly enhanced by the results of other recent biological survey work in the region. These projects have included: coastal wetlands inventory of Wisconsin's Lake Superior basin; St. Louis River wetland

evaluations; City of Superior rare plant survey; Apostle Island National Lakeshore surveys (for many taxa); Northern Highland-American Legion State Forest inventory; various Chequamegon-Nicolet National Forest projects; and the statewide breeding bird atlas.

Description of Study Area

The Brule River, located in Douglas County in northwestern Wisconsin, flows north and drains into Lake Superior (Figure 1). The entire 44-mile length of the river is contained within the approximately 40,000-acre BRSF boundary, a unique situation for a stream of this size. Though many privately owned tracts occur within the forest, the vast majority of owners have a strong interest in protecting the river, its watershed, and the area's natural beauty. This situation affords an excellent opportunity to achieve desired management and protection goals throughout much of the Brule River ecosystem.

A stable flow regime and cool summer water temperatures are among the major physical factors responsible for the ability of this riparian system to sustain its renowned coldwater fishery (DuBois et al., 1994). Glacial Lake Duluth, a predecessor of Lake Superior, formerly drained to the south and southwest, and partially created the present Brule and St. Croix River valleys. This unique post-glacial history, the river's steep-walled valley, the relative absence of development, and the exceptionally rich biota make this river system unlike any other in the region.

Like the rest of northern Wisconsin, the Brule landscape was subjected to catastrophic logging, often associated with severe fire, in the latter half of the nineteenth century and sporadically into the twentieth century. These events had dramatic impacts on the lands and waters of the study area and are still apparent today. In presenting these findings, we do not intend to criticize past or present use of the land, but rather to point out or emphasize particular protection and management opportunities for the future.

Ecoregions of the BRSF

The Brule River crosses three distinct ecoregions (Bailey, 1995), each of which is briefly described below and illustrated in Figure 2. Each ecoregion demonstrates unifying attributes that we have found useful in planning and structuring our fieldwork. Among ecoregional subsections (the level in the ecoregion hierarchy we reference), there are basic differences in geomorphic process, surface geology, lithology, and some soil and vegetation characteristics. Much more detailed information on ecoregions will be included in the Northern State Forest Assessments (WDNR, in progress, 1999), particularly in the reports entitled "Regional Ecology" and the soon to be released "Community Restoration and Old-growth."

Bayfield Sand Barrens (subsection 212Ka)

The Bayfield Sand Barrens ecoregion encompasses the headwaters of both the Bois Brule and St. Croix rivers and is characterized by sandy, nutrient-poor soils, level to steeply rolling topography, and local concentrations of kettle lakes and boggy depressions. Historically, this region supported extensive pine barrens and xeric pine-oak forests. Today, plantation-grown monocultures of pine constitute the most widespread vegetative cover.

Mille Lacs Uplands (subsection 212Kb)

The Mille Lacs Uplands ecoregion occurs primarily in Minnesota, extending into Wisconsin as a “wedge” between the Bayfield Sand Barrens and the Lake Superior Clay Plain. The rolling ground moraine supports a high diversity of habitat types, but the present vegetation of the uplands is mostly aspen forest. A ridge of igneous bedrock forms the northern boundary of this ecoregion and supports one of the few relatively extensive areas of northern hardwoods forest (sugar maple, basswood, red oak, white ash) in and around the BRSF.

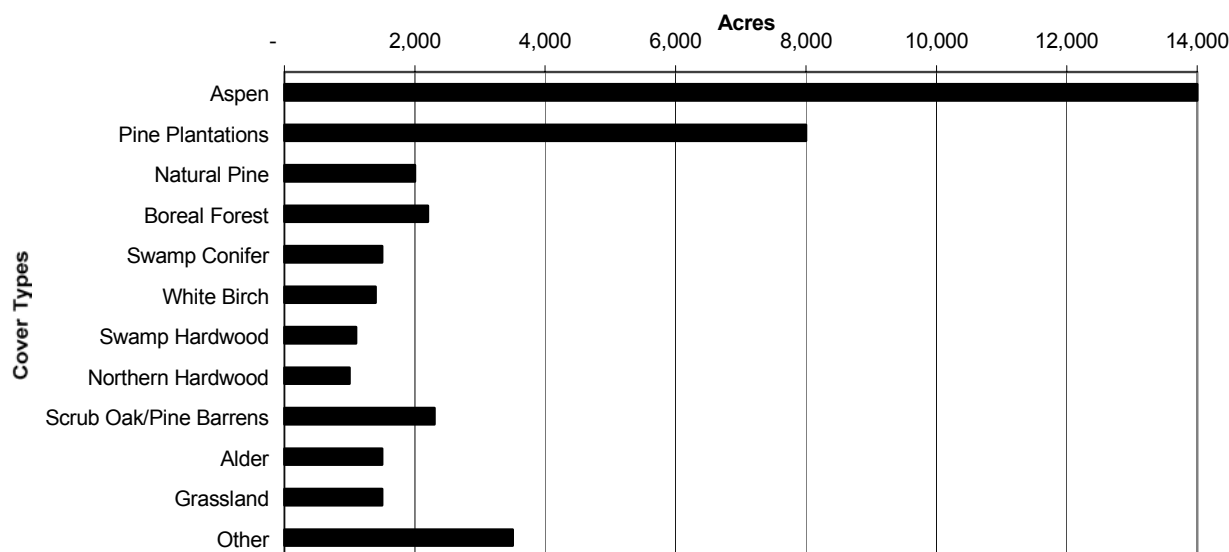
Lake Superior Clay Plain (subsection 212Ja)

Attributes of the Lake Superior Clay Plain ecoregion include level to gently sloping topography, heavy red clay soils, short steep-sided stream valleys, and a cool, moist climate moderated by the proximity of Lake Superior. This region contained Wisconsin's most extensive acreage of presettlement boreal (spruce-fir) forest. Virtually all of this forest was cut and burned, and, in most areas, aspen has replaced the boreal conifers. The present regional forest has been significantly fragmented due to the widespread conversion of forested lands to fields and pastures.

Generalized Land Cover

The boundary of the BRSF encompasses approximately 50,000 acres of land, of which roughly 10,000 acres are privately owned. The remaining 40,000 acres of public lands are vegetated primarily by aspen and pine plantation cover types, with smaller amounts of natural conifer and hardwood forests, grasslands, open water, and developed use cover types. Graph 1 depicts the acreage figures for each land cover type for state-owned lands only. Aspen and pine plantation cover types account for 55 percent of the total land area and over 70 percent of the forested lands on the state forest.

Graph 1. Land Cover Types of the BRSF



Source: Brule River State Forest Compartment Reconnaissance - December, 1998

We present these figures to give the reader a generalized overview of the study area's vegetation. Within any of these cover types, individual stands will exhibit differences in composition and in management potential.

Lands Surrounding the BRSF

Lands around the BRSF are mostly privately owned, including large tracts of industrial forest near both the headwaters and mouth of the Brule River. Small farms are common in the Lake Superior Clay Plain.

Douglas and Bayfield Counties own most public lands bordering the BRSF. The Douglas County lands, located west of the state forest, include the extensive and biologically rich "Blueberry Swamp". In addition, Douglas County lands contain one of the few relatively substantial acreages of northern hardwoods forest in the region, on the same bedrock ridge as the BRSF's "Sugar Camp Hill". Some of the state-owned lands along Highway 13 are not part of the state forest (see "State Highway 13 Grasslands" in Appendix B).

Pine plantations are very common on the sandy Bayfield County lands located to the east of the BRSF. There are some dry forest and barrens remnants on these county forest lands, but none of high ecological significance was found in the immediate vicinity of the BRSF.

Overview of Methods

Field Surveys

Reconnaissance surveys were conducted on the BRSF in 1995 by NHI ecologist Eric Epstein and botanist Dr. Emmet Judziewicz. These preliminary surveys identified those natural communities, aquatic features, and rare priority taxa warranting a more detailed inventory. Various experts conducted the detailed inventories during 1996. A limited number of surveys were conducted in 1997 to fill gaps in phenology and to more thoroughly cover some sites. Standard Natural Heritage Inventory methodology was used along with accepted protocol and procedures for the various taxa. Prior to entering the field, the following methods were used to assess the biological diversity of the BRSF. Greater details of these methods are explained in Appendix A. Detailed discussions of the field survey methods for natural communities, plants, and animals are in Appendices D, E, and F, respectively.

- Compilation of existing file information on the study area from sources both within and outside of the DNR.
- Literature review.
- Development of a target list of natural communities, rare plants and animals, waterbodies, and other significant natural features for the study area.
- Map compilation and development of a base map of the study area.
- Aerial photograph examination and interpretation.
- Original Land Survey Notes examination and interpretation.
- Interviews with experts (scientists, naturalists, land managers) knowledgeable about the study area.
- Information sharing among project participants.

- Aerial reconnaissance (fly-over).
- Analysis of information gathered and project planning.

Natural Heritage Inventory Overview

The BRSF inventory and analysis were conducted by the Wisconsin Natural Heritage Inventory program, which is part of an international network of NHI programs. The defining characteristic of this network, and the feature that unites the programs, is the use of a standard methodology for collecting, processing, and managing data on the occurrences of natural biological diversity. This network of data centers was established, and is currently coordinated by, The Nature Conservancy, an international non-profit organization.

The Natural Heritage Inventory programs focus on rare species, natural communities, and other rare elements of nature. When NHI programs are established, one of the first tasks facing the staff is to consolidate existing information on the status and location of rare elements. Before proceeding, the NHI program must determine what elements warrant "tracking" and which are more common. Similar to most states, Wisconsin biologists had a general idea of which species in the better-studied taxonomic groups (e.g., mammals, birds, and vascular plants) were rare or declining. For less-studied groups such as macroinvertebrates, the process of assembling the list of species to track and gathering the data were quite dynamic. Initially, NHI staff cast a wide net, collecting data on many species from existing sources (e.g., scientific literature, field guides, books, maps, and museum collections) as well as from direct contact with experts throughout the state. As more data were gathered, it was clear that some species were more common than originally thought and the NHI program stopped collecting data on them. Thus, the list of which elements are tracked, the NHI Working List, changes over time as species' populations change (both up and down) and as our knowledge about their status and distribution increases. This evolution continues today, with the NHI Working List typically going through several revisions a year. The current Wisconsin Natural Heritage Working List for the State of Wisconsin dated March 17, 1999 is found in Appendix G.

In general, there are two approaches to surveying biodiversity: (1) those focused on locating occurrences of particular elements, and (2) those focused on assessing the components of a particular area. The latter approach employs a "top down" analysis that begins with an assessment of the natural communities and aquatic features present, their relative quality and condition, the surrounding landscape pattern, and current land use and results in the identification of future species-oriented surveys. This approach, commonly referred to as "coarse filter-fine filter," concentrates inventory efforts on those sites most likely to contain target species. It also allows sites to be placed in a larger, landscape context for more broad applications of ecosystem management principles.

The BRSF inventory used the top-down, coarse filter-fine filter approach. The initial analysis assessed the entire region and determined the important ecological attributes and the biological processes supporting them. Criteria to evaluate sites were established and then vegetative communities were identified and characterized. Based upon existing habitat characteristics and known habitat preferences of various rare species, sites where species-specific surveys were most appropriate were identified. ***No doubt, occurrences of rare species exist that were not located through these inventories.*** However, by concentrating inventory efforts on the highest quality or otherwise suitable sites, it is most likely that the populations with the highest conservation value were located.

The NHI methodology for organizing and storing data is actually a system of three inter-related data storage techniques: structured manual information files, topographic map files, and a computer database

that integrates the various information. The computer component, known as the Biological & Conservation Data System, was developed by The Nature Conservancy for use by the Heritage Network. It is a sophisticated relational database management application built upon the Advanced Revelation application environment. Owing to the diversity and complexity of the information managed--from species taxonomy and ecosystem classification to real estate transactions--the system contains 36 database files and more than 2,000 information fields. The data in the Biological & Conservation Data System populate the NHI Geographic Information System.

Data Analysis and Site Identification

Following completion of our field work and the computerization of the collected data, the Natural Heritage Inventory conducted a staff workshop to evaluate the significance of the natural features we had surveyed from both local and statewide perspectives, and to identify those sites that encompassed the most significant features. Fred Clark of Clark Forestry, Inc. led the workshop and used techniques developed for similar evaluations in the Baraboo Hills of south central Wisconsin for The Nature Conservancy. Participants in this workshop were leaders for the NHI botany, zoology, and ecology programs, and staff from the Bureaus of Forestry, Facilities and Lands, and Science Services. The evaluations were guided by ranking factors such as: the number of populations of a rare species on the State Forest relative to the number known to occur statewide; the size of the populations on the BRSF compared to those elsewhere; the need for active management to provide for the long-term viability of rare species populations or natural communities; the extent, quality, and condition of the natural communities on the BRSF compared to those in the region; the degree to which inherent or potential ecological conditions on the planning unit (here the BRSF) increase the viability or defensibility of the rare species population or natural community; and the sensitivity of the rare species or community to management actions.

We consulted many sources to aid in the identification and prioritization of sites in and around the State Forest. Our basic references included the Bureau of Forestry's stand/compartments reconnaissance, interpretations of local and regional land cover from recent aerial photographs and satellite imagery, the original land survey notes for the region, and habitat type information newly derived from available data on landform, vegetation, and soils.

Other inventory work conducted recently in the northern and northwestern Wisconsin region (including Wisconsin's Lake Superior basin, the Apostle Islands, the Northern Highland-American Legion State Forest, the St. Louis River Estuary, and the Chequamegon-Nicolet National Forest, among others) gave us a solid basis for comparison and interpretation of the Brule River data.

Finally, individuals are encouraged to submit records for rare plants and animals that are on the NHI Working list. Additional information on how to submit data can be obtained from the WIDNR-BER in Madison, Wisconsin.

Summary of Results

The Results section summarizes the findings of this study according to sites, natural communities, rare plants, and rare animals and concludes with a discussion of the key ecological factors and processes occurring in the BRSF. Each of the groupings is summarized here but discussed in more detail in Appendices B, D, E, and F.

Certain species groups received relatively less attention than others. These include fish, mammals, non-vascular plants, and some invertebrates (especially terrestrial invertebrates). Reasons for these omissions include: (1.) insufficient existing data; (2.) too little is known about a group to interpret the information gathered within the context of a DNR property master plan; and (3.) the assumption was made that a “coarse-filter” community-focused approach to protection will conserve a significant portion of the unsurveyed taxa.

Sites

Inventory sites were identified within and around the BRSF and surveyed by NHI field biologists during 1995-97. Site files are maintained in the NHI offices in Madison, WI and include details on flora and fauna, data sheets, maps, aerial photographs, and other information.

The significance of each site was evaluated during the Ranking Workshop (see Methods section) according to condition, quality, and extent of the natural communities present; the number and size of the rare species populations; and the ecological context of these features. Many of the inventory sites were found to be of relatively low significance: they either had been greatly disturbed, supported only widespread or common species, or contained features for which much better examples occur elsewhere in northern Wisconsin. In general, these lands were pine plantation monocultures or in even-aged aspen cover.

These lands of lower significance do possess economic, recreational, and ecological values and may deserve consideration for long-term restoration or other special management designation. Their management can significantly impact surrounding lands. Therefore, management decisions for intact forest production or other intensively used sites should be considered as carefully as for the more ecologically sensitive areas. Note that the Brule River itself is a natural feature of the highest significance and one on which many of the other features included here are at least somewhat dependent.

From the Ranking Workshop, 45 sites emerged (Figure 3) that contained some feature of significance, raising their importance over the remaining sites. They include the best examples of both rare and representative natural features that were documented within and around the BRSF. The 44 sites are organized according to three categories defined below:

1. Primary sites - Selected inventory sites within the BRSF that contain the best examples of rare and representative natural features that were documented. All or significant portions of these sites should receive high protection or restoration consideration.
2. Outlying occurrences of rare species - Selected inventory sites located within the BRSF boundary that contain a rare species occurrence. These sites are generally very small and isolated from other more extensive natural features and thus may have a lower protection or restoration priority than primary sites.
3. External lands and waters - Selected inventory sites near but primarily outside of the BRSF boundary that contain the best examples of rare and representative natural features that were documented. Natural communities, rare species populations, and aquatic features are represented.

Sites categorized as external lands and waters have similar significance as primary sites, but are located outside the BRSF boundary.

Site descriptions for each of the 44 sites are found in Appendix B and organized according to the above categories. Information in Appendix B includes:

- location information,
- a site map showing occurrences of significant communities, species and aquatic features,
- a brief summary of the natural features present,
- the site's ecological significance (including a table of element occurrences), and
- management considerations.

Each site map¹ shows the site location against a background of a scanned USGS topographic quadrangle. The scale of the maps varies from 1:18,000 to 1:125,000 depending upon the size of each site and information presented (original USGS resolution is 1:24,000). Occurrences of rare or endangered species or natural communities are portrayed as dot symbols. Only those species or communities within the site or within 200 meters of the site boundary are portrayed in order to emphasize their location(s) relative to the boundary. Note that there may be more than one occurrence of one or more species or communities represented by any single "dot" (or symbol), that these symbols may overlap, and that the significance of the site is not based only on the presence of rare species occurrences. Also, the area of land the species or community occupies is frequently much larger than the dot representation.

Appendix C includes a master list of each of the 44 sites and the element occurrences that are located in or near them.

Site List and Characteristics

Table 1 is an overview of each of the 44 sites. The local and regional significance of each site is summarized and general comments are provided on management and other issues. The primary sites are arranged geographically, from the Brule headwaters north to the river's mouth at Lake Superior. Outlying occurrences of rare species and external land and water sites are listed separately after the primary sites.

¹ The maps should not be reproduced except by permission from the Bureau of Endangered Resources. These maps are for illustrative purposes only.

Table 1. Overview and Significance of Sites

Site Name (Map ID #)	Significance within BRSF	Ecoregional Significance Province/Subsection	Comments
Primary Sites			
Catlin Creek (35)	Medium/High	Medium	One rare aquatic invertebrate and 24 total invertebrate taxa present.
Porcupine Creek Headwaters (28)	Medium	Low	Unusual mixture of plants. Small site.
Brule Spillway Macrosite <ul style="list-style-type: none"> • Divide Swamp (23) • Angel Creek Swamp (22) • Jerseth Creek (20) • Stone Chimney Cedar Swamp (31) • Blue Springs-McDougal Springs (17) • Cedar Island - Winneboujou (15) 	High for all sites	High for all sites	Unique natural features complex. Extensive site, exemplary stands of several important natural communities (e.g. Northern wet-mesic forest, Northern dry-mesic forest, alder thicket, soft springs). Very high concentration of rare species. "Macrosite" is of statewide significance for several vascular plants, natural communities, and animals.
Mills Lake (24)	High	Low	Best example of community type that is rare on forest but common, more extensive elsewhere.
Smith Lake (21)	High	Medium	Very good example of regionally representative aquatic feature. Supports rare species.
North Country Trail Barrens (18)	High	Medium/Low	Best site for globally rare community on state forest. More diverse, larger examples occur elsewhere in this ecoregion, but site is still worth protecting.
Lake Minnesuing Hemlock-Hardwoods & Swamp (25)	Medium	Low	Small, isolated, not old-growth. Notable mostly because of Hemlock presence at extreme northwestern edge of range. Very high aesthetic value to local residents.
Buried Road Pines & Ponds (26)	Medium	Low	Older, but very small and isolated, stand of dry mesic-pine forest within matrix of intensively managed forest.
Vapa Road Pines & Ponds (19)	High	Medium	Older dry-mesic forest which could be expanded, linked to the Brule Spillway corridor. Site also contains ponds, wetlands. Rare species present.

Site Name (Map ID #)	Significance within BRSF	Ecoregional Significance Province/Subsection	Comments
Willard Pines (16)	High	Medium	Older stands of dry-mesic forest that could be expanded, linked to the Brule Spillway corridor. One rare species present.
Rush Lake (13)	High	Medium	Very good example of beach community borders undeveloped seepage lake. Excellent invertebrate community is also present.
Kurt's Deep Depression (14)	Medium	Unknown	Small kettle wetland. Pond supports significant aquatic invertebrate diversity. Barrens remnants occur on south and west-facing slopes of the kettle.
Devils Hole Red Pines (12)	Medium	Low	One of the few stands of natural red pine forest in the Brule, but small, isolated, and somewhat altered.
Hoodoo Lake (11)	High	Medium/Low	Few kettle bogs occur in the state forest. This one supports several rare species. Kettle bogs are common features regionally.
Afterhours Tamaracks (10)	Low	Low	Muskeg and bog forest communities are rare on the BRSF but common regionally. Site is small, isolated.
CCC Miller Boreal Forest and Pines (9)	Medium	Medium	Fair quality second-growth boreal and pine forest communities. Could be expanded, linked to other sites.
Sugar Camp Hill (8)	High	Medium	Most extensive mesic forest on the Brule, could be connected to pine forest, boreal forest, and river corridor. Several rare species occur here.
The Promontory (34)	High	Low	Contains cliff with one rare species. Bedrock features are much better represented outside of the state forest.
Lenroot Ledges (7)	Medium	Low	Best feature is older pine-cedar forest on private lands. Several rare species present. Could be linked to sites just to south (Sugar Camp, CCC Miller).
State Highway 13 Grasslands (6)	Medium	Low	Old farmland, supports grassland birds, but contributes to fragmentation of regional forest, and there may be adverse water quality impacts. Some of the resident grassland birds are uncommon and of regional concern.

Site Name (Map ID #)	Significance within BRSF	Ecoregional Significance Province/Subsection	Comments
Lower Brule Boreal Forest & Lake Superior Shoreline Macrosite <ul style="list-style-type: none"> McNeil's Landing Boreal Forest (3) Trask Creek-Weir Riffles Boreal Forest (2) Brackett's Corner Boreal Forest (1) Brule River Marsh and Lagoon (32) Bear Beach (4) Pearson Creek Boreal Forest (5) 	Overall High Potential High High Medium High High Medium	Overall High (with restoration) Medium Medium Low Medium Medium Low	Best opportunity to protect rare Boreal Forest community on state lands. Restoration is needed in most areas. Most land in the Clay Plain ecoregion is privately owned. The regional forest is severely to moderately fragmented, with aspen now the dominant cover type. Macrosite includes diverse marsh with rare species. Mouth of river heavily used by migratory birds. Several miles of undeveloped Great Lakes shoreline also heavily used by migratory birds. Rare species are present.
The Brule Annex <ul style="list-style-type: none"> Eau Claire River (30) Gordon Correctional Bog (29) 	High High	Medium/High Low	A medium-sized river with very high aquatic invertebrate diversity. A Small but very good example of regionally common community. Rare plant present.
Outlying Element Occurrences within the BRSF <ul style="list-style-type: none"> Bois Brule River Clevedon Road Hazel Prairie Road Wetland Jerseth Road Seeps Lawyer Bridge Bog Little Bois Brule River Ranger Station Riffle State Highway 13 Bridge 			All are small, somewhat isolated sites with one or more rare species. Significance varies with population size, management potential, and defensibility of the site. Contact BER for details as needed

Site Name (Map ID #)	Significance within BRSF	Ecoregional Significance Province/Subsection	Comments
External Lands and Waters beyond the BRSF Boundary <ul style="list-style-type: none"> Blueberry Swamp Casey Creek Grover Lake Nebagamon Creek 	NA NA NA NA	High Low Low Medium	<p>Good quality, extensive stands of several natural communities, many rare species. Swamp is the headwaters area of important Brule River tributary. One rare and 15 total taxa of aquatic invertebrate present on tributary of Brule.</p> <p>High aquatic invertebrate diversity</p> <p>Several rare species present. Important to protect stream banks and local watershed as this creek is an important tributary of the Brule.</p>

Natural Communities

Over 90 occurrences of 20 natural community types were surveyed within the BRSF. A master list of the natural communities of the study area, brief descriptions of each type, and an assessment of the significance of each type on the property and within the region, may be found in Appendix D. The following identifies community types that present high and moderate to low protection/restoration opportunities.

High Priority Protection/Restoration/Management Opportunities

Especially good opportunities to protect and manage the communities listed below now exist on the BRSF. These community types express major ecological themes of the Brule landscape. The types identified for high priority emphasis were selected because of their outstanding condition, high significance to both rare and representative native species, or because few other opportunities to manage these types exist statewide.

- **northern wet-mesic forest** (white cedar swamp, mixed swamp conifers): Extensive, exceptionally diverse, many rare species. Arguably, Wisconsin's exemplary occurrence occupies the Brule Spillway.
- **boreal forest** (white spruce - balsam fir): Highly significant restoration opportunity, with small, scattered mature remnants, to serve as templates and seed sources. Few alternative sites exist statewide.
- **springs and spring runs - soft:** High concentration of softwater springs and seeps, some with rare invertebrates, occurs along the upper Brule.
- **northern dry-mesic forest** (white pine - red pine - red oak): Small but significant stands of older pine forest are and were prominent on the flanks of the Brule Valley. Restoration opportunities exist, and this type could be expanded via a long-term shift in management emphasis.
- **alder thicket:** Extensive and undisturbed, especially along the upper river.
- **stream - slow, soft, cold** (upper Brule): Sluggish, soft-bottomed, and meandering, the upper Brule is fed by numerous springs and supports a significant assemblage of coldwater organisms and a diverse complex of wetland communities.
- **stream - fast, soft, cold** (portions of the middle and lower Brule): The Brule River is a unique aquatic system in the Lake Superior basin owing to its post-glacial history, the assemblages of aquatic organisms it supports, and the fact that the entire river is contained within a state forest boundary. The middle and lower river contain significant stretches of rapids and fast water.

Additional Protection/Restoration/Management Opportunities

For the following natural communities, opportunities for protection and management were judged to be somewhat lower than for those mentioned above. This was mainly due to limited acreage, present condition, or our knowledge of more extensive stands in better condition elsewhere in northern Wisconsin. Keep in mind that no single community should be evaluated solely on its individual merits, as context can be critical. Some of the types listed below occur in close association with types of greater significance and their values may be correspondingly higher.

- **pine barrens** (jack pine-prairie grasses and forbs) - limited acreage of this globally rare community occurs on the state land, but modest opportunities to maintain and expand remnants exist and should be seriously considered.
- **northern dry forest** (jack pine-Hill's oak) - Management of this type should be integrated with the barrens community. Acreage of this community has been greatly reduced statewide recently.

- **northern mesic forest** (maple-basswood, maple-hemlock) - Though very limited in extent on the BRSF, one or several of the surveyed stands merit consideration for special management designation.
- **emergent aquatic** (bur-reed - bulrush-cattail) - Widespread throughout Wisconsin but limited on the BRSF. However, some excellent stands occur in the low gradient "widenings" of the lower Spillway and at the mouth of the river. Rare plant and animal species were documented in this and the next community.
- **submergent aquatic** (pondweed-coontail) - Comments under "emergent aquatic" also apply here.
- **hardwood swamp** (black ash-red maple) - Very limited acreage, mostly on low terraces within the river corridor. Few management or use conflicts were noted. Usually within aesthetic and/or erosion control zones.
- **tamarack swamp** (tamarack-alder) - Small but good quality stands occur within the Brule Spillway and have been treated as inclusions within the white cedar-dominated "northern wet-mesic forest."
- **open bog** (sphagnum mosses - sedges-ericaceous shrubs) - Common and widespread throughout much of northern Wisconsin. Two small but significant examples occur on the forest.
- **muskeg** (similar to open bog, stunted black spruce-tamarack) - Common and widespread throughout northern Wisconsin and the region. Much better represented elsewhere.
- **poor fen** (sphagnum mosses-sedges) - Status uncertain in the state, but fens are probably common and widespread in the north (many of Wisconsin's "open bog" communities would be considered "poor fen" elsewhere).
- **northern sedge meadow** (bluejoint grass-sedges) - Widespread in the north, but not well represented on the BRSF.
- **northern wet forest** (black spruce-tamarack) - Widespread in northern Wisconsin, but some important stands occur within the Brule Spillway.
- **dry cliff** - Rare on the BRSF and much better represented elsewhere.
- **Great Lakes dune** (marram grass-beach pea) - A single, very small, and rather battered occurrence is at the mouth of the river. It does function to protect a high quality marsh from excessive ice and wave action.
- **Great Lakes beach** - Though beaches on this part of Lake Superior are very dynamic entities and seldom support any permanent vegetation at all, they are important foraging and resting sites for many migratory birds. An extensive, undeveloped beach occurs west of the Brule's mouth and merits protection.
- **interior beach** - one excellent occurrence is present on the BRSF. As development pressures on lake and stream shores are increasing rapidly in many parts of northern Wisconsin, this site merits strong protection.

Rare Plants and Animals

"Rare" plant and animal species are treated here as native species known or suspected to be rare and/or declining in the state. Included are species legally designated as "Endangered" or "Threatened" by either the State of Wisconsin or the federal government, as well as species in the Department's advisory "Special Concern" category and the U.S. Fish & Wildlife Service's "Candidate" and "Species of Concern" lists. Rare species information for the BRSF was compiled from existing records in the BER NHI Biological Conservation Database (BCD), field inventories, and other data sources as described in Appendices E and F.

Appendix E provides detailed information and lists of rare plants for the BRSF. **Twenty** rare plant species were documented, including two WI endangered and three WI Threatened. The BRSF appears to contain the largest overall populations of Calypso orchid (fairy slipper) (*Calypso bulbosa* - WI Threatened), Lapland buttercup (*Ranunculus lapponicus* - WI Threatened), and sheathed sedge (*Carix vaginata* - WI Special Concern). Other important examples of rare plants include:

- fir clubmoss (*Lycopodium selago*) - WI SC
- autumnal water starwort (*Callitriche hermaphroditica*) - WI SC
- showy lady's slipper (*Cypripedium reginae*) - WI SC
- small yellow lady's slipper (*Cypripedium parviflorum*) - WI SC

Appendix F provides detailed information and lists of animals for the BRSF. **Thirty-two** species of rare animals were documented, including two WI Threatened and one US Threatened. Formal breeding bird surveys were conducted at 12 sites within the BRSF. Aquatic insect diversity on the main stem of the Brule River is excellent and reflects the high level of water quality in most of the river. A significant population of wood turtles (*Clemmys insculpta* - WI Threatened) is present in the Bois Brule River and some of its tributaries. The BRSF represents a significant opportunity to provide secure habitat for this species in NW Wisconsin. The same can be said for the northern goshawk (*Accipiter gentilis* – WI Special Concern) and the entire suite of “boreal” birds.

The Brule Spillway contains a concentration of softwater springs and spring fed streams, some of which support invertebrates which are very rare in WI and the eastern United States. See write-ups in Appendix F for: a predaceous diving beetle, zebra clubtail, and the two Diamesin midges. Shallow ponds with fluctuating water levels in a “barrens” landscape are fairly well represented here. Some of these are rich in, or contain rare, macroinvertebrate taxa.

Key Ecological Processes And Attributes

Within the context of the work completed for this project, the key ecological processes of high importance to the maintenance and protection of the natural features on and around the Brule River State Forest include:

1. **Hydrologic processes** - Among these are groundwater recharge, springhead discharge, and fluctuations in base level flow and water temperature. The geologic processes of erosion and sedimentation are also of significance here, as they directly impact water quality and habitat suitability.
2. **Fire**. Many of the natural communities and species found on the Brule were influenced by wild fire in the past. The impacts of long-term fire suppression are ecologically significant and need to be addressed in the future.
3. **Herbivory** - Browse pressure, especially from white-tailed deer, is currently heavy in much of the State Forest. Negative impacts on sensitive conifers are especially noticeable and significant.
4. **Natural Succession** - Older successional stages are rare on and around the State Forest, including those community types that would typically be represented by old-growth and other late successional stages in the Brule landscape. Conversely, communities characterized by a poorly developed canopy of trees and historically maintained in an open condition by fire, such as pine barrens, have also become very rare. Most have grown up into dense forests or have been planted to pine monotypes.

Besides fire, other natural disturbances that can be directly or indirectly responsible for initiating or maintaining successional processes include windthrow, ice storms, insect infestation, and flooding.

5. **Immigration and emigration** - Several native species are now absent from the Brule landscape with few opportunities to recolonize due to habitat changes, disruption of dispersal corridors, and an insufficient land base. Non-native species have invaded terrestrial, palustrine, and aquatic communities and have displaced, or threaten to displace, additional native plants and animals (examples are leafy spurge, reed canary grass, and the sea lamprey).

Key attributes of the present landscape include:

1. **Landforms** - In the region of the Brule headwaters, the predominant landform is a glacial outwash plain. Portions of this region are rolling and dotted with small kettle lakes, elsewhere the landscape is pancake flat. A rolling glacial moraine is the dominant landform of the middle portions of the Brule. An east-west trending ridge forms the northern boundary of this part of the region and is the only location in which bedrock outcroppings occur. The lower Brule flows through nearly level glacio-lacustrine deposits, dissected by short steep-walled stream valleys.
2. **Soils** - In the upper Brule landscape, the soils are mostly sands of low nutrient content. In the middle Brule the soils are a mixture of sands, loams, and silts. Along the lower Brule the soils are mostly heavy, thick, red clays.
3. **Vegetation** - Moderate to severe fragmentation, simplification, and loss of both older forest successional stages and semi-open, non-forested communities characterize the current vegetation compared to the historical condition. Aspen and plantation-grown pine (mostly red) comprise the majority of the present cover types on and around the Forest.
4. **Representative and rare species** - Population levels of some species have changed markedly in recent times in concert with habitat and land use changes (e.g. the fluctuations of sharp-tailed grouse). A few species have been entirely eliminated owing to habitat loss, persecution, or for reasons unknown. This group includes top predators (Canada lynx), large herbivores (moose and woodland caribou), and several plants (marsh ragwort, mountain cranberry).

The reintroduction or reestablishment of some of these is very problematic because of past habitat changes, the current conditions on and around the Forest, and the needs of the individual species.

5. **Land use** - Dominant land uses are recreation, commercial forestry, and agriculture. Residential development (and associated infrastructure such as roads and utility corridors) is substantial in and around some parts of the State Forest.

Considerations and Ecological Priorities

Key Issues for Consideration

There are five key issues that are important to the ecological future of the BRSF and should be considered during master planning. These are not ordered according to importance but rather are nested within a hierarchy of scales ranging from the regional to the local level.

1. Three major ecoregions (see Figure 2) are represented within the BRSF. The lower Brule River area, part of the Lake Superior Clay Plain ecoregion, presently affords the only major opportunity to restore a conifer-dominated boreal forest on any state land throughout Wisconsin. The Bayfield Sand Barrens ecoregion contains the unique and regionally significant “Brule Spillway.” The Mille Lacs Uplands ecoregion is a rolling landscape with the potential to support diverse native vegetation.
2. Activities and processes occurring beyond the State Forest boundaries influence many of the Brule River’s natural features and ecological processes directly or indirectly. Examples include groundwater recharge, the primary water source for the upper Brule and its many springs and seepages; fragmentation caused by road construction, residential development, logging, agriculture and utility corridors; and increasing human population pressures via recreation and other uses, especially those which demand products or space. Progress on these fronts will require efforts that are directed at the larger landscape, by the Department as well as other entities.
3. The BRSF encompasses the entire main stem of the river within its boundary. This affords unique opportunities for the protection and management of a river of this size, a large portion of its watershed, and the associated natural processes, communities, and species.
4. Aspen and plantation-grown pine are the most abundant and dominant vegetation cover types on and around the forest. Approximately 70 percent of the state-owned forested land within the BRSF boundary is in aspen or pine plantation cover types (see Table 2 on the following page). Opportunities exist to restore the composition of the forest to something that better reflects ecosystem potential in terms of natural communities, which will increase diversity in the present landscape.

Some recent BRSF management activities, especially in the clay plain, have favored the regeneration of the native conifers. It is highly desirable to progress toward a goal of increased conifer dominance, at least in selected areas, using a variety of methods (including “passive” prescriptions). Boreal forest and native pine forests are high priorities for restoration in the Brule landscape.

5. The “Brule Spillway” contains natural communities, aquatic features, and a concentration of rare plants and animals of exceptionally high significance. Figure 4 shows the frequency of NHI “element occurrences” (see Natural Heritage Inventory Overview) in the region of the BRSF. There is a higher density of element occurrences within the Brule Spillway than elsewhere in the BRSF or any of the surrounding areas.

Ecologically, this site is not comparable to any other in Wisconsin, and it merits consideration for the highest level of protection. The core protection area to consider extends from the headwaters downstream to Winneboujou (roughly Highway ‘B’), and from bluff top to bluff top across the Brule valley. In addition, there may be critical water recharge areas beyond the bluff tops.

General Considerations for Master Planning

A number of general considerations for master planning have emerged from the analysis of the existing ecological processes, biotic data, and land use for the BRSF. They are grouped into two categories: considerations related to conservation challenges and limitations, and restoration challenges.

Conservation Opportunities, Challenges and Limitations

1. **Size of the Property** - At approximately 42,000 acres, the BRSF is not large enough by itself to accommodate certain scale dependent species (such as the timber wolf) or landscape level attributes and processes (e.g., large scale forest interior conditions) capable of conserving all forest interior organisms and their interactions.
2. **Linear Configuration of the Property** - Much of the state forest is only two miles wide. This makes it difficult to address some of the major conservation issues of the BRSF within the property boundaries alone. Some use conflicts will be more acute because of this factor.
3. **Context of the Property** - The Brule Landscape includes industrial forest and, in the north, many farms. Roughly 20 percent of the land within the BRSF, and most of the land surrounding it, is private.
4. **Fragmented Landscapes** - In both the upper and lower sections of the property, habitat has been fragmented. The most strongly affected habitats within the study area are the forests in the north and pine barrens in the south.
5. **Existing Forest Cover** - Table 2 provides the acreage figures of cover types for state-owned lands within the BRSF. Aspen is presently the major cover type, occupying (with paper birch) approximately 50 percent of the *forested acreage on the state-owned land*. Aspen is also abundant throughout all three of the major ecoregion units within which the state forest occurs. Aspen-dominated stands have replaced most of the boreal forest of the Lake Superior Clay Plain ecoregion, which historically was conifer-dominated (see Appendix D for community descriptions). In the Brule landscape, aspen stands also now occupy many sites that formerly supported forests of pine and northern hardwoods. An aerial survey over the clay plain in mid-October of 1996 revealed clearly that aspen is dominant throughout the region, not just on the State Forest. Upland conifer forests are relatively scarce and, where present, are generally small and isolated, restricted to steep slopes, or consist of plantation monocultures.

The emphasis on managing for aspen can, in some areas, limit options for managing or restoring certain important natural communities and/or successional stages. This, in turn, can make it difficult to successfully manage populations of certain rare or otherwise sensitive species. Related factors include the high herbivore density often associated with extensive aspen management, the creation of additional high contrast edge habitats which generally favors those herbivores (and can also create conditions favorable for nest predators and brood parasites), and an increase of the habitat fragmentation that is now so characteristic of much of this landscape.

Table 2. Cover Types for State Lands in the BRSF

<i>Cover Type</i>	<i>Acreage</i>	<i>Percent of Total</i>	<i>Percent of Sub-total</i>
State-owned Forested Lands			
Aspen	14,000	35%	45%
Pine Plantations	8,000	20%	26%
Natural Pine	2,000	5%	6%
Boreal Forest	2,200	6%	7%
Swamp Conifer	1,500	4%	5%
White Birch	1,400	4%	5%
Swamp Hardwood	1,100	3%	4%
Northern Hardwood	1,000	3%	3%
<i>Sub-total of Forested Lands</i>	<i>31,200</i>	<i>80%</i>	<i>101%</i>
State-owned Non-forested Lands			
Scrub Oak/Pine Barrens	2,300	6%	26%
Alder	1,500	4%	17%
Grassland	1,500	4%	17%
Other	3,500	9%	40%
<i>Sub-total of Non-forested Lands</i>	<i>8,800</i>	<i>23%</i>	<i>100%</i>
TOTALS	40,000	103%	

Source: Brule River State Forest Compartment Reconnaissance - December, 1998

6. **Pine Plantations** - Much of the land capable of supporting key native natural communities in the southern half of the state forest, such as dry forest and pine barrens, has been planted to pine monocultures. Plantation cover types now occupy ca 25% of all state-owned forested acreage on the BRSF. Consideration for the long-term restoration of diminished natural communities is key, as they have been significantly reduced not only in the vicinity of the Brule, but range-wide as well.

A recent large-scale infestation of the jack pine budworm led to the damage or destruction, and subsequent salvage, of many thousands of acres of dry, jack pine-dominated forest in northwestern, north-central, west-central, and central Wisconsin. Most of the salvaged acres, especially on county and industry-owned lands, have already been planted or replanted, often to red pine. It is important for the state and other public land managers to develop alternative management scenarios that do not eliminate extensive patches of either pine barrens or jack pine/scrub oak forest from the landscape.

7. **Ecological Capability and Ecological Potential** - Each of the three major ecoregions (subsection level) represented on the BRSF have different ecological capabilities based on climate, glacial history, landform, soil type, disturbance history, competition, and other factors. These ecoregions also have different ecological potentials to support forest communities and species. For example, the soils of the Lake Superior Clay Plain are capable of supporting both intensively managed stands of aspen and limited agriculture (mostly pasture “grasslands”), but also have the potential to (and formerly did) support a diverse boreal conifer-hardwood forest community with complex structure. The trade-offs between forest production, biological diversity, restoration and other possibilities will need careful consideration by the master planning team. The relationships between these wide-ranging goals will vary, from complimentary to conflictual.

Management decisions need to consider not only the ecological capability of the land, but also the management of surrounding lands. Much of the land on the BRSF is capable of supporting aspen or plantation-grown pine and has been managed accordingly. However, virtually all of the surrounding

lands have been managed in a similar manner resulting in a homogeneous and simplified regional land cover and an incomplete representation of the ecological potential of this landscape.

8. **Ownership Patterns** - Numerous private holdings occur within the state forest boundary. Because these boundaries tend to follow cultural lines rather than ecological features, several important sites are vulnerable to incompatible uses or developments.
9. **High Road Densities** - In general, areas with sandy soils or concentrations of lakes have high road densities. Where these two factors coincide, as on the Northern Highland State Forest, road densities and the related problems of fragmentation, isolation, disturbance, and development pressure can be especially high. This is also true for portions of the BRSF landscape, especially in the south.
10. **Regional Conflicts** - Many divergent interests, projects, and goals exist within the BRSF region. State and federal agencies, county and local governments, and private industry and landowners may have dissimilar goals (i.e. management goals) based upon their particular interests. Conflicts may exist, both within and outside of the BRSF boundary, that will present challenges for the future management of the BRSF landscape. Tradeoffs are common elements of any implemented management plan.
11. **Dispersed Information** - In the past, it was very difficult to pull together all of the information needed to provide a regional perspective on management opportunities and considerations for a particular property. A series of WDNR reports collectively entitled "Northern State Forest Assessments" is nearing completion and will be available in the future. These reports cover biological topics such as Biodiversity, Community Restoration and Old-growth, and Regional Ecology, as well as socio-economic issues. The information provided in these reports will consolidate background information useful for property master planning and other applications.

Restoration Challenges

In the body of this report we have highlighted ecological features of special significance within or adjacent to the BRSF boundary. Many of these features merit consideration for special protection and management because of their rarity, regional or range-wide decline, vulnerability, or because they are especially representative of this landscape. We have given emphasis to "restoration" of lost features only when the choice seemed obvious because of an absence of alternative sites (e.g., in the case of the boreal forest community), when the proximity of other significant natural features nearby made restoration seem like an especially worthwhile and reasonable objective (the Brule Spillway), or when the community to be restored is regionally rare and a land base capable of supporting it exists on the property (North Country Trail Barrens).

Important points are:

- Tried and true methods for the restoration of forest (and most other) communities do not exist. Actions will be at least somewhat experimental, with no outcomes guaranteed. It should not be assumed that leaving things alone will expedite matters, nor that this option should be ignored.
- Much of the intensively managed land dedicated to forest products (such as pine plantations) has long-term capability for the restoration of more natural vegetation. This does not imply that restoration of these lands is the best thing to do, or the most practical, or that future harvest would be prohibited. But restoration should be identified as an option and a realistic timetable for achieving goals acknowledged up front.
- At this point, the successful restoration of certain extirpated species seems unlikely. The moose, woodland caribou, and Canada lynx are among those species whose habitat needs are not met by current conditions, either on or around the state forest. The BRSF is not, by itself, large enough to maintain populations of these species. In addition, open country species with large spatial

requirements, such as the sharp-tailed grouse, will decline locally as new pine plantations mature, especially in the southern part of the Brule River drainage.

The timber wolf occurs as a resident on and around the BRSF, but maintaining packs will require a coordinated protection effort, involving various owners, to meet the management challenges presented by the state forest's small size, linear configuration, and relatively high road density. For a regional overview and recommendations for the timber wolf, see the Wisconsin Wolf Management Plan (1999).

- Goals and objectives for restoration, and methods to be used, need to be clearly defined and developed within an appropriate ecological context.

Ecological Priorities

The Bureau of Endangered Resources bases the following ecological priorities on careful analysis. They reflect assessment and inventory of the region surrounding the BRSF as well as the property itself. They are organized around a number of primary issues: management and protection, restoration, land use, and monitoring. The Department's master planning team will use these ecological priorities to develop overall recommendations for the forest, and will also consider social, economic, and other ecological needs. Research and inventory priorities are also listed, although they may be more useful in identifying follow-up actions to master planning. Site specific information and considerations are provided in the site descriptions section (see Appendix B).

BRSF Management

1. Re-examine the boundaries of the two designated State Natural Areas within the Brule Spillway to include additional features that are ecologically significant. The Brule Spillway is currently the most important site, ecologically, on the BRSF. Both of the existing State Natural Areas are small, and in neither case do the boundaries coincide with ecological or major cultural features in the area. Creating a single, large, special protection and management area within the Spillway is one option, but others may also be worthy of consideration.
2. Consider sites containing features representative of each of the forest's major ecoregions for special protection and management. The candidates should cover a broad spectrum of natural communities, rare or otherwise sensitive species populations, and aquatic features, emphasizing those that are especially well represented on the BRSF or are rare globally or regionally.
3. Consider adjusting BRSF boundaries to include additional natural features. Several important sites lie at least partially outside of the BRSF boundary and merit additional protection. Examples include: Smith Lake, Nebagamon Creek, Blueberry Creek, Blueberry Swamp, and the Lower Brule Boreal Forest. Boundary adjustments to address these needs and opportunities should be considered. Hoodoo Lake, a significant aquatic/wetland site with an interesting geologic history, is within the State Forest boundary, but all of the lands (and wetlands) along the shore are privately owned.
4. Establish a plan for protection priorities that would employ acquisition, conservation easements, and other land protection methods. This would include both lands within the current Forest boundary and, potentially, lands outside of that boundary. High ecological priorities for future protection include:
 - a) key tracts for watershed protection (including, but not limited to riparian lands),
 - b) any tracts within, or where land use could negatively impact, the Brule Spillway and shoreline habitats,

- c) additional lands containing high quality or restorable boreal forest or pine barrens,
 - d) high quality aquatic features, and
 - e) lands that would extend Forest ownership out to the nearest road (or similar cultural feature) and maintain or create management flexibility and efficiency.
5. Provide endangered resources information to land and water managers in the field. Information on locations, sensitivities, and needs of rare species which could be impacted by habitat modification should be exchanged with managers as early as possible. Develop monitoring protocols as needed to measure the response of both target and non-target associated species/habitats to management activities. The same should be done for at least a subset of the natural communities.
 6. Explore methods of reducing deer densities and/or impacts where browsing has reached problem levels.
 7. Existing and potential travel/dispersal corridors for organisms sensitive to habitat fragmentation, including certain large mammals, need identification and/or protection. This should be done along both west-east and north-south axes.
 8. Site specific management considerations are provided as part of the Site Descriptions in Appendix B.
 9. General recommendations and management considerations for natural communities and rare species are found in Appendices D, E, and F.
 10. Identify exotic/invasive species issues and develop control strategies as appropriate.

Restoration

1. Restore the boreal forest community in the Lake Superior Clay Plain ecoregion. Restoration efforts directed toward the boreal forest community of the lower Brule should not only aim to increase the conifer component of stands in that area, but also to increase stand size and age. Reforestation should be considered at appropriate locations. Given the uncertainties involved in this restoration attempt we recommend a broad, adaptive approach, which might run the gamut from “hands-off” to intensive active management.

The prevalence of aspen in current stands should not drive the future management of those stands before the ecological impacts of doing so are better understood and alternative management opportunities have been carefully weighed.

2. Maintain larger blocks of mature, closed canopy forest in the boreal restoration zone. Clearcutting, with retention of conifers, should not be ruled out if it can be shown that progress toward increased conifer dominance is accelerated. However, this need not be the sole method of implementation. A broader landscape and community level restoration plan is recommended.
3. Investigate the feasibility of removing the dam on the Eau Claire River above Gordon. Fragmentation of stream habitat in the upper St. Croix River basin may be limiting lake sturgeon reproduction. Dam removal would also restore the ability of mussel populations to move between the St. Croix and Eau Claire Rivers and provide additional habitat for macroinvertebrates and fish.
4. The Mille Lacs Uplands ecoregion contains a high diversity of habitat types but this is not currently reflected in the present cover types. Further investigation of management options may be warranted.

Land Use

1. Land Management classifications have been established per Chapter NR44 of the Administrative Code for the Department of Natural Resources. The classifications are used in developing, revising and amending master plans. In some cases, site recommendations (provided with site descriptions in Appendix B)

suggest limitations or guidelines to land management and must be expressed in the land management classifications. BER staff will work with the Planning Team to help develop and evaluate alternatives for the state forest and appropriate surrounding areas based on the findings of this study.

2. Develop a long-term plan to address forest fragmentation. The Master Plan could recommend initiating a long-term plan to address related impacts, such as small stand size, stand isolation, an abundance of high contrast edge, and excessive browse from white-tailed deer.
3. Clarify the sources of increased runoff and sediment loads to the Brule River and its tributaries, especially in the Lake Superior clay plain. The higher percentage of open (non-forested) land north of highway 'F', and road and utility corridor maintenance activities, are among the potential sources of runoff problems.
4. Assess opportunities to work with local citizens, non-government conservation organizations, private organizations, and public agencies and land managers in the region to influence the landscape surrounding the BRSF.

Monitoring

The following suggestions comprise an initial list of monitoring needs. We realize that neither our bureau nor other programs in the Department are able to undertake these actions immediately, but we feel that it is important to identify issues now within the context of a new planning cycle. These suggestions are intended to be factored into master planning to help develop an overall monitoring plan. Final priorities should reflect the preferred alternative selected through master planning.

1. Establish permanent monitoring plots for vegetation types with impaired function (e.g., poor reproduction by canopy species). White cedar swamps (wet-mesic forests) and boreal forest are the highest priorities. It is important to collect baseline data as part of process toward future management. Also, consider disturbance dependent communities such as pine barrens and northern dry forest (jack pine) as priorities.
2. Re-sample historic vegetation plots (e.g., at Divide Swamp and "Brule Bog" (Blewett, 1976)) and analyze the data.
3. Design and implement a monitoring program for rare plant species such as Lapland buttercup, fairy slipper, fragrant fern, and sweet coltsfoot. Other species may be equally or more suitable.
4. Establish permanent breeding bird transects (with points). One to several of these could be canoe transects, as the conifer swamps along the upper Brule would be very difficult to access by land (this would limit coverage to only a few points in a single morning). Road transects would be efficient for portions of the lower Brule. At a minimum, conifer swamp, boreal forest, and pine forest should receive attention, but it would be desirable to include pine barrens, aspen, pine plantations and grasslands as well. Large habitat patches should be the highest priority. Integrate efforts with state or regional projects when possible.
5. Perform ongoing monitoring of Ebony bog haunter dragonfly (*Williamsonia fletcheri*) population at Hoodoo Lake.
6. Perform ongoing monitoring of aquatic macroinvertebrate communities at representative sites:
 - Bois Brule segments (as used by Dubois, 1993),
 - springs and spring runs,
 - examples of cold, cool and warm water streams,
 - Smith Lake.
7. Repeat benthic invertebrate sampling per Dubois (1993).
8. Develop monitoring component (built-in) for any restoration program (e.g. boreal forest and pine barrens).

Research

1. Re-evaluate management of sensitive vegetation types dependent on disturbance for their long-term maintenance. Examples include pine/oak forests and pine barrens. Where significant changes to a community are likely to result in a loss of valued ecological attributes (function, structure, composition), we need to carefully examine options. If fire cannot be safely or economically used, is silviculture a viable option? If so, are existing prescriptions adequate? If not, who will develop them?
2. Thoroughly explore the reintroduction of fire as a management tool, especially in the barrens landscape of the upper Brule. The implications of continued fire exclusion need to be examined. Alternative methods of maintaining open or semi-open habitats need careful assessment, as they are not risk-free, inexpensive, or likely to accomplish all desired objectives.
3. Additional research is clearly needed to develop effective methods to reduce the quantities of fine sediments reaching the river and Lake Superior. A special erosion control zone has been established by state forest staff to provide maximum protection to the fragile bluffs flanking the river. This has arrested erosion to a degree. However, where past historic damage was especially severe, such as on the lower Brule, the slumping of the red clays continues. We support previous recommendations made by DuBois (1993), including continued acquisition of riparian land, sedimentation studies, and a water quality monitoring program.
4. Determine taxonomic status of aquatic insects that are potentially very rare throughout their range:
 - *Caenis youngi*, a rarely reported mayfly, has been found in a range of habitats that suggest there may be more than one species involved.
 - A Diamesin midge (*Protonypus* sp.) collected on the Brule was not identifiable to species in the larval form. Species determination could be accomplished by rearing larvae to adults or placing emergence traps in larval habitat. Whatever species is (are) found here represent a significant range extension.

Inventory

1. The mouth of the Brule River and the Lake Superior coastal area should be more thoroughly inventoried for aquatic invertebrates, terrestrial invertebrates, and important bird use areas.
2. Identify and protect the communal or traditional wood turtle nest sites.
3. The Mille Lacs Uplands ecoregion may warrant additional survey and/or restoration consideration.

Glossary of Terms Used in This Report

aquatic macrophyte - vascular plants with special adaptations to aquatic habitats (lakes, streams, springs).

barrens - Also known as "pine barrens". A natural community characterized by sandy soils of low nutrient content, vegetation adapted to periodic wildfire, and, under a disturbance regime of wild or prescribed fire, an open structure resembling a prairie or savanna.

BRSF - the Bois Brule River State Forest

Brule Spillway - that portion of the Brule River Valley above the Highway B bridge crossing that was the outlet of glacial Lake Duluth, a predecessor of Lake Superior.

cover type – a simplistic and generalized but sometimes useful method of classifying land based on the species forming the most significant portion of the vegetation. The term may also be used to broadly describe other surface cover, e.g. "open water," grass," etc.

diversity - used in this report as a shortened form for biological diversity, or biodiversity. A general definition (Matthiae et al., 1993) is "the spectrum of life forms and the ecological processes that support and sustain them. Biological diversity is a complex of four interacting levels: genetic, species, community, and ecosystem."

element - elements are the basic building blocks of the Natural Heritage Inventory. They include natural communities, rare plants, rare animals, and other selected features such as colonial bird rookeries and mussel beds. In short, an element is any biological or ecological entity upon which the Natural Heritage Inventory considers important to gather information for conservation or related purposes.

element occurrence - An individual example of an element (a natural community, rare plant population, rare animal population, or other feature tracked by the Natural Heritage Inventory program) at a specific geographic location.

ericaceous - pertaining to a family of plants, the Ericaceae, especially characteristic of highly acidic habitats such as bogs. Members include such well-known plants as blueberries, cranberries, leatherleaf, Labrador tea, and bog rosemary.

exemplary - Used in the report to describe aquatic (and occasionally other) communities or assemblages that are especially good representatives of their respective types. Usage of the term, while subjective, includes comparison of like types based on their diversity, water quality characteristics, disturbance history, and values to scientific study.

fragmentation – the breaking up of large and continuous ecosystems, communities, and habitats into smaller discontinuous areas that are surrounded by altered or disturbed lands or aquatic features.

inventory site - also "site" in text. The geographic location at which a biological survey has been conducted. These may be large or small, depending on the nature of the species or community surveyed. Boundaries may be finite and discrete (a property boundary, a single stand of a forest community), or rather arbitrary. When sites become very large (exceeding several thousand acres) and encompass complex landscapes, they are sometimes referred to as "macrosites" (see below).

macroinvertebrate - Used in the report to refer to aquatic insects and mollusks.

macrosite - see "inventory site." Two or more standard inventory sites in close proximity, where consideration of their collective attributes is in some way related to the viability and ecological values of the larger whole. Scale is usually in 1000's of acres or more.

mesic - moist, well-drained (not too wet, not too dry).

natural community - an assemblage of plants and animals, in a particular place at a particular time, interacting with one another and the abiotic environment around them, and subject to primarily natural disturbance regimes. Those assemblages that are repeated across a landscape in an observable pattern constitute a community "type." No two assemblages, however, are exactly alike.

Natural Heritage Inventory - a system developed by the science division of The Nature Conservancy for collection, management, and use of biological, ecological, and related information. In Wisconsin, the Natural Heritage Inventory was established by action of the state legislature in 1985, after which the program was installed within the DNR's Bureau of Endangered Resources.

old-growth – used in this report to refer to forests characterized by large trees, large standing snags, abundant down wood ("coarse woody debris") on the forest floor, a complex multi-layered canopy, pit and mound microtopography ("tip-ups"), and many other attributes. Definitions can vary for specific forest community types for a variety of reasons.

State Natural Area - formally designated sites that contain outstanding examples of native biotic communities and are often the last refuges in the state for rare and endangered species of plants and animals. Areas are devoted to scientific research, the teaching of conservation biology, and especially to the preservation of their natural values and genetic diversity for future generations. The Department of Natural Resources currently administers 326 State Natural Areas encompassing more than 120,000 acres of land and water.

TNC - The Nature Conservancy, a private conservation organization responsible for developing the standardized methodology used by Natural Heritage programs. The Wisconsin Chapter has actively worked for many decades with private landowners in the Bois Brule watershed to secure conservation agreements.

xeric - characterized by excessive dryness.

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